

2008 Update of Biology Strategic Plan

Executive Summary

The Biology Department at CWRU proposes to continue building on its current three areas of excellence, to which the Department committed in its 2000 Strategic Plan as revised in 2004:

- **Neuromechanics and Adaptive Behavior**
This focus area emphasizes emergence of adaptive behavior from the interaction of nervous system, biomechanics, and the environment, and includes analysis of mechanisms of learning. This area is the focus on research and scholarship of five faculty within the Department (Chiel, Ritzmann, Willis, Wood, Zull). It also integrates the graduate program at the MetroParks Zoo as well as collaborations with colleagues in Engineering (e.g., BioRobotics in Mechanical Engineering).
- **Disturbance Dynamics of Ecosystems**
This area focuses on responses of ecosystems to perturbations such as fire or other stressors and the mathematical analysis of transient behavior, and it explores implications for conservation and management of natural resources. The area is the research focus of three faculty within the Department (Drewa, Koonce, Snyder) and involves collaborations with the science program at the Holden Arboretum (Topa, Burke, Smemo).
- **Developmental Biology and Tissue Engineering**
The unifying themes for this focus area involve developmental genetics and the analysis and control of stem cells for regenerating tissue. Five faculty within the Department have research focus in this area (Atit, Caplan, Cullis, Haynesworth, Rozek) and it involves a variety of collaborations with Clinical and Basic Science Departments in the School of Medicine as well as the Skeletal Research Center's collaborations with Orthopedics and the Cleveland Clinic.

We have also developed a cross-cutting initiative in **Systems Biology and BioMathematics**, including developing a new undergraduate B.S. degree in Systems Biology, and a new program in Research at the Interface of Biology and Mathematics (RIBMS) funded by the NSF. This closely connects to the research focus of three faculty in Biology (Chiel, Koonce, Snyder), three in mathematics (Thomas, Calvetti, Gurarie), as well as faculty in Engineering and Medicine. New hires who will join the Department next year are likely to add critical mass in another cross-cutting initiative, the **Evolutionary Biology Program**, which involves the Departments of Anthropology (Cynthia Beall), Anatomy (Scott Simpson and Darin Croft), Genetics (Mark Adams), and the Center for Global Health (Peter Zimmerman). The undergraduate program has been developed in part through the Department of Philosophy (Patricia Princehouse).

All of these major areas will provide the basic science necessary to achieve several of the Strategic Academic Alliances in the University Strategic Plan. Through targeted faculty hires and enhanced infrastructure these areas will continue to rise in national prominence and enable the Department to sustain an excellent graduate program.

The Department has also developed an outstanding curriculum in Biology that helps prepare students for careers in biological research and biotechnology. These activities have led to:

- Revision of the Biology core curriculum to emphasize hands-on, active learning
- Creation of new B.S. program in Systems Biology
- Creation of new electives and labs that emphasize experiential learning
- Opportunities for student research, including the Summer Program for Undergraduate Research
- Creation of a new M.S. program in Entrepreneurial Biotechnology

The Department goals are to maintain and enhance this curriculum and continue efforts to move undergraduate and graduate education in Biology to the forefront of changes that are coming nationally to revise biology instruction for the 21st century.

In the future, the Biology Department is enthusiastic about fully participating in the SAGES program, as well as enhancing the preparation of students interested in careers in the health professions. However, the increased undergraduate class size and the full implementation of SAGES have led to unprecedented increases in the teaching load of the Department. Consequently, the Department must consider plans to cope with a nearly three-fold increase in majors within the short term, which may not fully accommodate all of our students. We suggest that this could be the basis for a College-wide discussion about staging the full implementation of SAGES so that no students are prevented from graduating. The Biology Department must cope with some very difficult challenges over the next few years. To fulfill our obligations, as well as build the scholarly environment envisioned by the University faculty, immediate and ongoing support from the University is imperative.

I. Current and Future Areas of Excellence and the College Strategic Plan

Our strategy has been to develop three areas of expertise, but to hire faculty whose breadth of interests has allowed them to develop cross-cutting initiatives that are likely to lead to two new areas of excellence over the next ten to twenty years. In particular, hires of faculty with interests in **Systems Biology** has begun to draw together the three existing areas, and new hires into existing areas with strong interests in **Evolutionary Biology** are creating the basis for two new areas of excellence within the Department. At the same time, experience has shown that a critical mass of faculty in each of the areas (at least four or five research-active tenure track faculty) is essential for providing the intellectual environment and support that allows an area to flourish, and thus to recruit and train outstanding graduate students. Thus, we project that the Department of Biology should grow to a total of 25 research active tenure-track faculty within the next ten to twenty years. All of the collaborations that we have established within the College, within the University (i.e., in Engineering and Medicine), and with other area institutions, critically depend on the strength of the research enterprise within Biology itself.

The current areas of excellence, and those that we propose to develop, directly address the Strategic Academic Alliances in the University Strategic Plan. Within the area of **Energy and Environment**, the response of ecosystems to perturbation is critical for understanding how different energy policies will affect current ecosystems, how to conserve biodiversity while utilizing natural resources, and provide a theoretical underpinning for understanding energy flows within normal ecosystems. Thus, the **Disturbance Dynamics of Ecosystems** research focus provides essential scientific support for this Strategic Academic alliance. In addition, at least one current faculty member (Cullis) is focusing on date palms as oil producing plants, which could directly contribute to the development of novel biofuels.

Within the area of **Human Health**, understanding the dynamics of the nervous system, neuromodulation and motor control are vital for developing rational therapies for diseases of the nervous system. Thus, the **Neuromechanics and Adaptive Behavior** research focus contributes to the basic science for this goal. Furthermore, understanding stem cells and their normal control within developmental processes, as well as the genetics of development, will be crucial for curing diseases due to developmental dysregulation, or aging. As a consequence, the **Developmental Biology and Tissue Engineering** will provide the basic science and biotechnology expertise that will be critical for this goal. Finally, to begin to develop an understanding of how changes at one level of a biological system (e.g., a mutation, or the introduction of a new disease vector) can alter populations, the tools and techniques developed by the **Systems Biology** faculty within Biology and in other Departments may play a vital role for planning the future of health care.

Within the area of **Culture, Creativity and Design**, several members of the faculty have strong interests in learning and memory (Zull), and have ongoing interactions with members of the Cognitive Science Department (Zull, Ritzmann and Chiel), so that the **Neuromechanics and Adaptive Behavior** research focus will aid in the understanding of the biophysical, neurophysiological and biomechanical mechanisms that contribute to the flexibility and adaptability of behavior that underlie the complex creative behavior of humans.

Finally, within the area of **Social Justice and Ethics**, the Biology Department is enthusiastic about exploring joint programs with the Inamori International Center for Ethics and Excellence in the area of bioethics, and with the Law School in developing programs in Law, Public Policy, and Society.

In the remainder of this strategic plan, we will describe the short-term, medium-term and long term goals, challenges, and how we will respond to them so that we can ensure that our areas of research excellence, which provide the basis for our teaching, will continue to flourish and rise in national eminence. We have also provided two appendices that summarize the growth in the teaching load of the Department (Appendix I) and a statement of the basic principles underlying the Biology Plan and its relation to the University Strategic Plan.

II. Short term Goals, Challenges and Responses

Goal: Strengthen our areas of research excellence.

Challenge: Ongoing faculty turnover [Appendix I, Figure 6].

Response: We must hire more tenure-track faculty so that we do not lose any FTEs, and we increase the research activity of the faculty within our areas of research excellence.

Goal: Create an excellent and self-sustaining graduate program.

Challenge: Enormous increase in number of graduate students within the last five years [Appendix I, Figure 4]

Response: Cross-listing of graduate courses is our current, short-term response. In the longer term, we must provide more courses targeted directly to our graduate students and we must aggressively pursue training grant opportunities (see below).

Goal: Maintain the excellence of our undergraduate program.

Challenge: We face an unprecedented increase in class size, number of majors [Appendix I, Figures 1 and 2], and full implementation of SAGES, especially the Capstone requirement. There is a very large mismatch between teaching needs and teaching capability within the Department as it is currently configured (Figure 1 and Appendix I, Table 1).

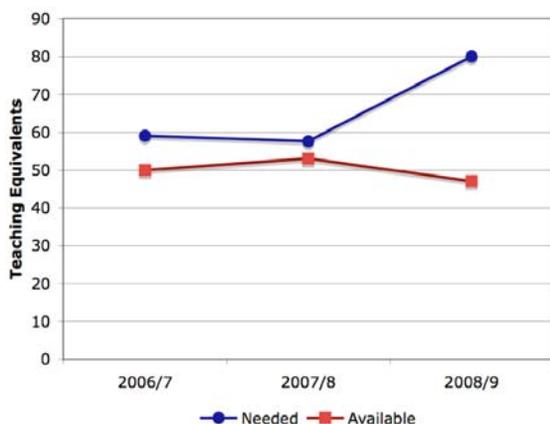


Figure 1. Comparison of teaching loads required to fill the student demand for undergraduate biology courses offered by the Department of Biology, Biology SAGES assignments for First Seminars, University Seminars, and Department Seminars, and the SAGES capstone.

Response: We have developed several alternatives to address the immediate problem, and we have several short-term solutions, but there is a high risk that we will not be able to

accommodate all of our students. *Thus, the College may need to discuss a staged implementation of the Capstone requirement.* Potential solutions are:

- Research capstones may be done in one semester of the Junior or Senior year, allowing students four possible semesters in which to complete the requirement.
- Students will be advised to plan ahead and contact Biology faculty members as early as possible, well in advance of the semester in which they plan to do their Capstone, because there are far more majors than research active faculty available within the Department.
- Students who are majoring in more than one subject will be encouraged to obtain their Capstone through another Department.
- Students who are particularly interested in medically relevant research in the biological sciences will be encouraged to contact faculty in the Medical School to obtain their Capstone.
- The Biology Department currently has two project-based labs that can accommodate 15 to 20 students for Capstones.
- The Biology Department has created 389S, which will allow students to write a library based research paper as a Capstone.
- The Biology Department is seeking approval through the Curriculum Committee of a new course, that will allow students to participate in group projects, for which they will jointly write a final report, similar to the Senior Projects in the School of Engineering.
- If the College provides the resources, the Department could create a Project Lab with a full time coordinator who could guide students to do research projects as Capstones. This would require a full time salary for the coordinator, and space for the project labs. If approved, this could be operational by Spring 2009, and could accommodate 50 to 60 students. NB: The number of projected Capstones is in the range of 130 to 140; number of research projects that we have historically accommodated in the Department is 10 to 15, and through school of Medicine is another 15 to 20; we anticipate that the proposed solutions will only cover 100 to 110 of our majors.
- In the short term, because of the need to accommodate so many Capstones for our majors, the Department will only be able to provide minimal support for other SAGES teaching obligations.

To accommodate the larger class sizes, we are also implementing and considering curricular changes: reducing the laboratory requirements, separating the core course lectures from the labs, streamlining requirements for the B.S. program, adding sections to key elective courses, and creating new electives to relieve crowding in our existing elective courses.

III. Medium term Goals, Challenges and Responses

Goal: Continue strengthening the research excellence of the Department by increasing the number of tenure track faculty to 20 over the period 2011 to 2013.

Challenge: The age structure of the Biology faculty will place substantial stress on the ability of the Biology Department to maintain and improve the research excellence of the major focus areas of the Department. By 2011, five of the six Professors will be at or beyond normal retirement age. There is also risk of departure of other tenure track faculty. In addition, the Biology Department has limited space for additional research laboratories.

Response: Maintaining two course teaching load for research-active faculty in the tenure track is absolutely required to have a viable graduate program and a productive research program in the Department. Because research active departments with research opportunities for undergraduates will remain a competitive attraction for future undergraduates, the Department must keep a substantial fraction of its faculty engaged at the cutting edge of research. Many Biology faculty members are directly competing for grant support with faculty in Medical Schools whose teaching loads are generally much less than a single course. Until the College of Arts and Science relieves the current capacity limit of about 15 research labs on campus. To alleviate space constraints on faculty expansion will require additional lab space and office space for tenure-track and non-tenure-track faculty. Each research lab and faculty office for experimentally active faculty requires 1,200 to 1,500 sq. ft. of space. Depending on the mix of non-tenure track and tenure track hiring over this period, we will need on the order of 2,000 to 8,000 sq. ft of additional space. Should additional space be limited, future hiring will require a mix of experimental and theoretical faculty in the Department and will require that the ecology faculty have most of their lab facilities at the Biological Field Station. We also face infrastructure limitations for high performance computing facilities and access to critical library resources.

Goal: Improve the formal training program for graduate students in the Biology Department through the creation of additional graduate courses in the areas of research focus and through the development of Department-wide mentoring and training programs.

Challenge: Maintaining the graduate program requires a critical mass of faculty in each area of research to write successful research and training grants to support graduate students, to mount graduate courses tailored to graduate students (and separate from undergraduate courses), and to provide thesis committees for graduate students.

Response: The Biology Department will need to add 6 to 8 courses at the graduate level. In addition, the Biology Department will need to increase the availability of graduate student training opportunities in teaching and provide regular mentoring workshops for career development.

Goal: Develop new and exciting curriculum opportunities for undergraduate that promote active learning throughout the Biology curriculum, provide distinctive opportunities to prepare for careers in research, the health sciences, and biotechnology, and enable full participation of the Biology faculty in SAGES.

Challenge: The impediments to achieving this goal involve large class sizes, the popularity of premedical studies, full implementation of SAGES, and limited space for Biology teaching labs.

The Undergraduate Pre-Medical Studies: It is likely that the new undergraduate class size will lead to a steady state increase of about 25% in total number of Biology majors, to about 100 students per year. With increased number of students and no increase in faculty size, it will be difficult to maintain the quality of the instruction for pre-med students. It will be especially difficult to keep upper elective courses small enough that students have any individual connection with teaching faculty. The survival strategy outlined above for the short term explicitly favors Biology majors, but many pre-medical students choose to major in other areas (e.g., Psychology or Chemistry), so that the short-term strategy jeopardizes our ability to provide competitive pre-medical training. Moreover, unless

students have outstanding instruction and research experiences, our ability to get students into their top choice Medical Schools will be threatened. CWRU's ability to recruit top quality students will be affected if the percentages of students admitted to medical schools falls significantly at a time when admission to Medical School is exceptionally competitive.

SAGES: All our majors should have the option to do research-based capstones, but this is simply not feasible given the current faculty size, and the other teaching and research demands on research-active faculty. We are thus left with a major challenge to provide a pedagogically effective and efficient manner to administer these. In addition, the Department would like to add more First, University and Department Seminars, but this is not compatible with the priority of meeting the educational needs of our majors.

Infrastructure: Existing teaching lab space (4 wet lab teaching environments) limits expansion of laboratory instruction. Labs for the core courses (BIOL 214, 215, and 216) must be offered in non-concurrent sessions and evening; creating registration conflicts where none existed previously. This has proven an especially vexing problem for double majors. To minimize these conflicts would require 50% increase in wet-lab teaching space. Expansion of project based labs will also require an additional modular teaching lab of about 800 sq. ft.

Response: At present time, interest in premedical studies dominates the admissions profile of students entering the College of Arts and Science. When confronted by similar trends the University of Chicago implemented a policy of involving all of the biological science faculties in training undergraduates and graduate students. At CWRU, this policy would be the equivalent of forming a Division of Biological Science, which would join the Biology Department with the Medical School basic science departments and possibly the Department of Biomedical Engineering. Creation of such an administrative unit will cause the College to lose revenue associated with biology program and the associated tuition revenue stream. Keeping the Biology Department in the College of Arts and Science and maintaining its integrative approach to biological sciences will require growth of the Department and reshaping the entering class. To serve both ends, it seems clear that strengthening other liberal arts programs will help reduce the overwhelming demand for courses serving pre-med students and enable the University to create a true pre-medical studies program that couples dedicated advising and curriculum improvement. This investment appears to be much more stabilizing than doubling size of Biology department.

IV. Long term Goals, Challenges and Responses

Goal: Fully develop five areas of outstanding research excellence, each of which will have five research-active tenure track faculty

Challenges: Start up funds for new faculty, space for their laboratories without further fragmenting the Department, and faculty development funds, and other infrastructure (shared equipment, shared computing facilities, support for library acquisitions of biologically-related literature, especially for ecology, plant biology, and nonhuman biology), departmental infrastructure.

Responses: Add faculty to each of the current three areas of excellence so that the faculty can contribute to the two cross-linking areas. Then add faculty directly to the two cross-linking areas so that these research areas are capable of functioning more independently. This will also require additional space, which may require the construction of a new Biological Sciences research facility, along with renovations to the Biology Field Station at Squire Valleevue Farm. An increase in faculty number will require additional staff for budget, administration, purchasing, the graduate program, computer and equipment maintenance, and coordination within and among the different research groups. Finally, the College needs to create and endow a faculty development fund that will allow the Department to continuously invest in the growth and development of each faculty member's research program.

Goal: Enhance and sustain an outstanding graduate program

Challenges: Stipend support, ability to do rotations prior to choosing a lab, space for shared graduate student activities, laboratory space, and courses targeted solely to graduate students

Responses: As research-active tenure track faculty are added to the Department, their grants will begin to provide additional support for more advanced graduate students. In addition, by increasing the research-active faculty, it will become feasible for faculty to mount graduate courses that are targeted towards their own research areas. However, to allow students to do rotations before choosing a laboratory, the Department will need to aggressively pursue training grants. By creating sufficient research strength in each of the research areas, it may be feasible for each area to pursue its training grants, in addition to a Department-wide training grant. If the College has created a new Biological Sciences research facility, this could have common space for graduate students, to allow them to interact, fostering cross-disciplinary research. These space requirements along with those needed for faculty expansion to 25 tenure track faculty members will require 12,000 to 15,000 sq.ft. of additional space.

Goal: Enhance and sustain an outstanding undergraduate program

Challenges: Large number of majors, full participation in SAGES, providing undergraduate research experience to every student who would like it, diversifying the interests of incoming students, providing a competitive edge for our graduates and for those pursuing careers in the health sciences

Responses: Ensure that research-active faculty teach both core and elective courses in their areas, so that they can share the excitement of current, ongoing research with students; Work to synchronize our curriculum with changing requirements for medical school curricula; in addition to research-active faculty, hire instructors or non tenure track faculty to teach bulk of introductory, large-enrollment courses, and project based labs. Provide an endowment to create an internal grant program so that students can apply for small research grants to defray the supply expenses for their independent projects. Provide space for and fully fund supplies and personnel for excellent teaching labs for the students; again, this could be part of a future Biological Sciences research facility.

Appendix I: Documentation of Changes in the Department's Teaching Responsibility in the Last Few Years

With recent increases in the size of the entering class and full implementation of the SAGES curriculum, the Biology Department is facing substantial challenges in meeting its teaching obligations. Indicators of these challenges include increases in numbers of declared Biology majors (Figure 1), dramatic increases in numbers of students graduating with a Biology degree (Figure 2), and increasing demand for independent study (Figure 3). Adding to these challenges is a remarkable growth of the graduate program (Figure 4).

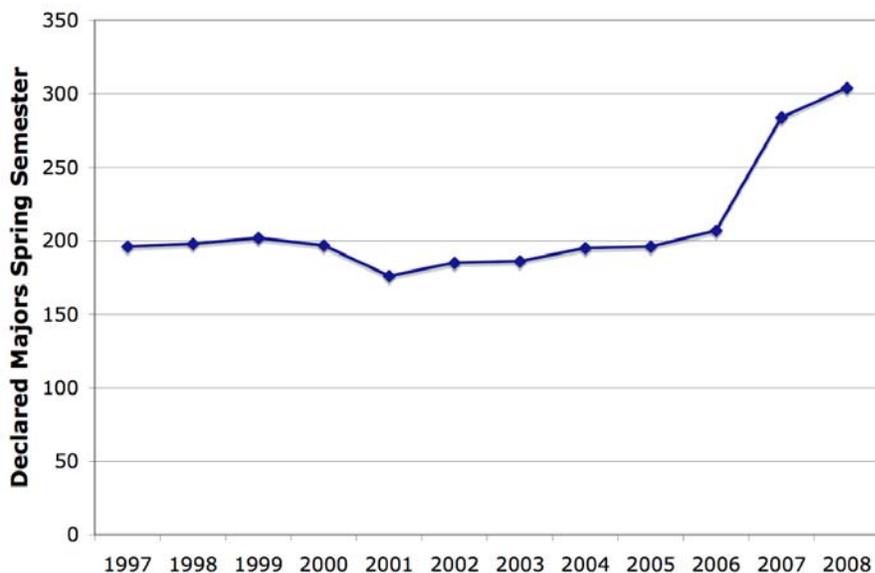


Figure 1. Summary of declared Biology majors (BA and BS degrees) at start of spring semester. Data from Office of the Registrar, semester enrollment statistics (<http://www.case.edu/provost/registrar/stats.html>). The number of Biology majors in spring 2008 is the largest among undergraduate programs. By the end of the spring semester, the number of majors was actually over 350. So next year is likely to be above that number.

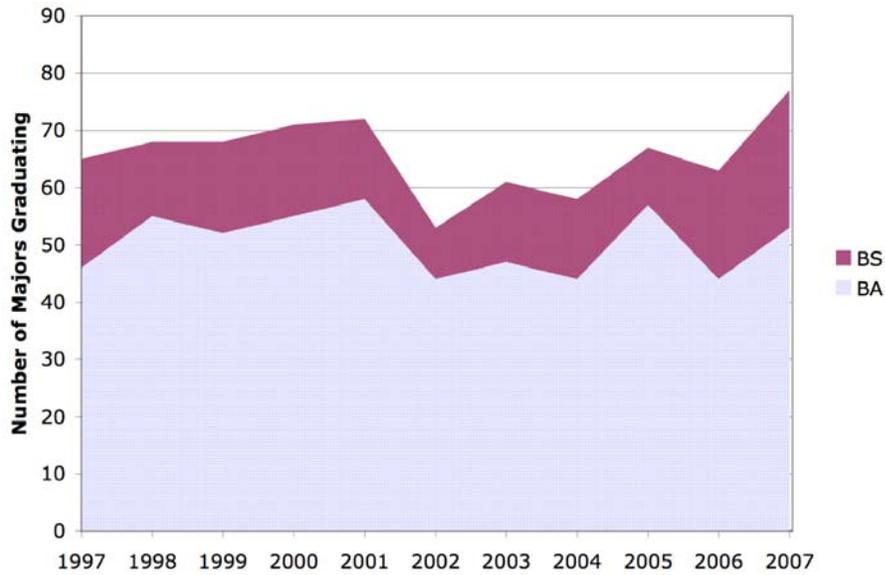


Figure 2. Summary of numbers of graduating biology majors as of May commencement from 1997 to 2007, data Office of Undergraduate Studies (<http://www.case.edu/provost/ugstudies/graduating/gradstats.htm>). Graduating majors in spring 2008 will be in the 130 to 140 range, doubling the long-term average.

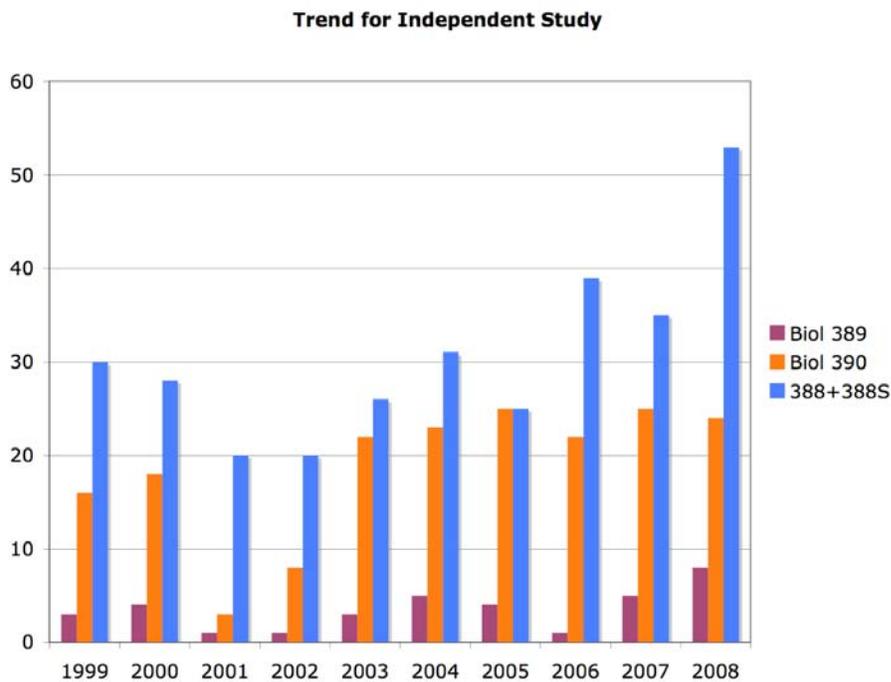


Figure 3. Summary of trends in independent study for the period 1999 to 2008 by enrollment in Biol 388 and 388S, Biol 389, and Biol 390. Data from Office of Registrar, course summary by department (<http://www.case.edu/provost/registrar/crsesum.html>). Number of anticipated individual capstones for 2008 is 120, which is a doubling from 2007

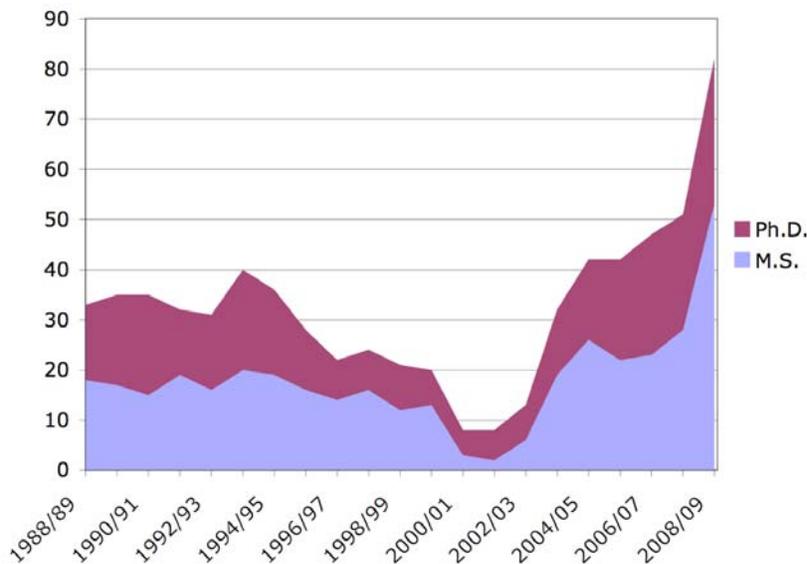


Figure 4. Summary of graduate enrollment in the Department of Biology in M.S. and Ph.D programs for the period 1988/89 to 2008/09. Final year's data are estimates. Part of increase in recent years is associated with the need for TAs in the introductory Biology sequence (BIOL 214, 215, and 216) and Biology electives.

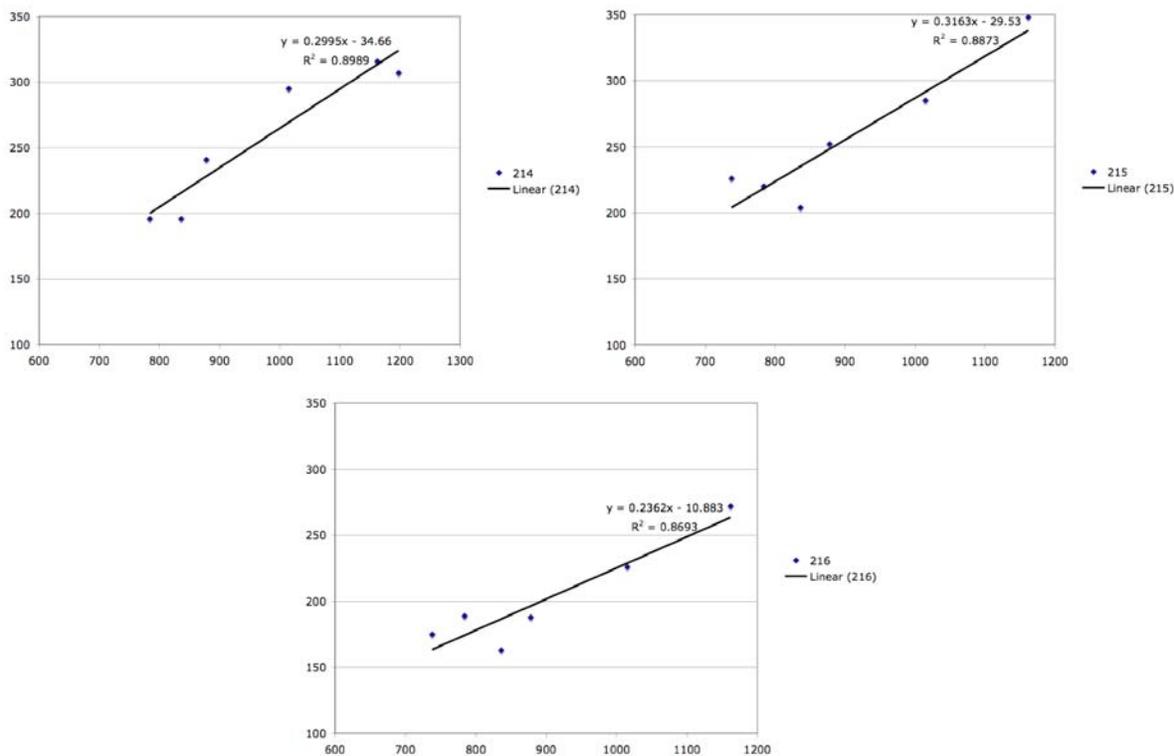


Figure 5. Relations between entering class size and enrollment in Biol 214, 215, and 216, which is the required introductory sequence in Biology for Biology majors and premeds. Biochemistry majors also use the first two courses in the sequence.

We anticipate a disproportionate increase of majors over the next several years given the new degree program in Systems Biology and the growing interest in careers in the biological sciences. We project a new steady state number of majors in excess of 100 per year in the coming years, which is nearly a 100% increase over historical numbers of majors per year. The number of majors who will be graduating in Spring 2009 (134) is more than twice the pre-SAGES historical number of majors (which ranged between 55 and 65 per year); in May of 2010, we already have 88 committed majors, and the rate at which students are declaring majors for 2011 would also suggest a class of about 130 students. Concerns of the Biology faculty include:

- The current Major requirements state that students must take at least two elective lab courses, and the new SAGES requirement imposes a Capstone project as well;
- Many of our majors also benefit from the option of completing other majors in addition to Biology, creating scheduling conflicts with existing labs;
- The nominal teaching loading for research-active faculty is two courses, which is highest among peer institutions that we have surveyed;
- For non-tenure track faculty, or tenured faculty no longer active in research, the nominal teaching load is four courses, limiting the number of additional lab sections that the Biology department can offer.

An additional challenge is that our graduate program has grown from 7 students in 2000 to over 80 students as of next fall (25 Ph.D., 19 entrepreneurial M.S., and 18 Plan A M.S. and 18 Plan B M.S. students), creating additional pressures for new graduate courses. The undergraduate advising load has exploded from an average of five students per faculty member in 2000 to about 25 students per faculty member, requiring the Department to use lecturers and visiting faculty as advisors. The increase in graduate students has also increased the advising load of the research-active faculty.

During this unprecedented increase in demand on the faculty, the number of FTEs within the Biology Department has not increased and is beginning to decline (Figure 6). In addition, the physical infrastructure for offering labs has remained unchanged. Table 1 summarizes the alarming shortfall of teaching capacity for the 2008-2009 academic year. Not included in these data are the 4 to 6 graduate course equivalents needed each year nor the shortfall in Biology obligations to the SAGES program, which have been 3 First Seminars, 1 University Seminar every other year, and sufficient Department Seminars and Capstones to cover our majors. The shortfall in the first three seminars is about 10 per year.



Figure 6. Trends in faculty size (full-time equivalents for tenure track and non-tenure track faculty) in the Department of Biology over the past twenty years.

Table 1. Summary of teaching loads and nominal expected teaching assignments for the two year period prior to full implementation of SAGES and the first year of full implementation of SAGES. These summaries are for undergraduate courses only. UG BIOL FTTE are the full-time teaching equivalents for undergraduate biology courses offered by Biology faculty. BIOL Ind (5) is the effective course load for groups of five students in independent study, and FS & US are First Seminar and University Seminar offerings by Biology faculty. Nominal AFTTE are the nominal full-time teaching equivalents assuming two courses per year for tenure track faculty and four courses per year for non-tenure track faculty.

	2006/7	2007/8	2008/9
UG BIOL FTTE	42	44	54
BIOL Ind(5)	13	10.6	25
FS & US	4	3	1
Total FTTE	59	57.6	80
Nominal AFTTE	50	53	47

Appendix II: Guiding principles for plan

I. Guiding principles inherited from the University Strategic Plan

The Mission of Case Western Reserve University in the University's Strategic plan call for three categories of actions:

- Undergraduate, graduate, and professional education that is active, life-changing, and innovative;
- Scholarship, creative endeavor, and research that lead to new knowledge addressing society's new and enduring questions and most pressing challenges; and
- Promoting an inclusive culture of participatory, responsible, global citizenship.

Collectively, the University faculty has envisioned a scholarly environment that pursues goals in education, research, and service through commitment to a University that:

- Nurtures a community of outstanding scholars who are highly collaborative and collegial, functioning in an atmosphere characterized by support, mentoring, and inclusion.
- Supports the development of thriving disciplines as well as interactions among these disciplines to address the complex questions and issues facing humanity, maintaining a deep appreciation for all forms of inquiry.
- Strives continuously to provide the highest quality education for our students, focusing on innovative, active, multifaceted learning to drive intellectual and career development and to contribute to society.
- Pursues distinctive opportunities for learning and discovery that build on our special features, such as our excellent teaching and research, our collaboration with the world class health care, cultural, educational, and scientific institutions that are our neighbors in University Circle, our commitment to sustainability, our proximity to key natural resources, and our international partnerships.

The Biology faculty embraces these principles. We interpret them as giving the highest priority to the establishing an outstanding faculty, whose research and teaching attract an outstanding student body. We believe that there are three key elements necessary to implement these principles:

(1) **Recruit the best faculty.** Provide them with competitive start up, excellent infrastructure, and opportunities for growth.

(2) **Help the best faculty flourish.** Regularly invest in faculty by providing release time, equipment, materials and supplies and student support. Reward faculty who do outstanding research, or outstanding teaching, or outstanding service. On a regular basis, the Chair of the Department should have the resources to be able to ask each faculty member: What can we do to help you do your best work?

(3) **Keep the best faculty.** Maintain competitive salaries through all ranks. Develop appropriate spousal hiring policies to ensure that both members of an academic couple can be retained. When other universities attempt to recruit away outstanding faculty, fight to keep them.

Excellent faculty members attract and inspire outstanding undergraduate and graduate students. Recruiting, retaining, and fostering the growth of the best students should be a faculty goal. Success in achieving this goal should be reflected in the University's tenure and promotion policies.

II. Given these principles, what does it mean to be a great Department of Biology in a College of Arts and Sciences (as opposed to one in a Medical School)

General principles for faculty development: faculty in the Department must pursue research areas that are both sustainable and maintain the Department's independence, and enhance its educational mission:

- The preponderance of faculty members must be active in research.
- Faculty should maintain funding levels that are appropriate for their area of research (e.g., funding levels in ecology or mathematical biology may be very different than those in the neurosciences or in developmental biology)
- The focus of the faculty's research should not completely or mainly overlap research in the Medical School but should be complementary (e.g., research in plant biology, invertebrates or lake ecology, which are not generally studied by Medical School researchers)
- The Department should strongly encourage highly interdisciplinary and collaborative research that fosters connections within the College of Arts and Science, with the School of Medicine, and with the School of Engineering
- The Department should also foster excellence in teaching, and have some teacher-scholars, whose research focus is on enhancing education and evaluating the relative merits of different teaching methods.

General principles for curriculum development: there are fundamental themes that characterize all biological systems, from the level of molecules to the level of ecosystems, and these principles should organize teaching so that students can grasp the major themes themselves, and ultimately contribute to research in biology. The Department will strive to create coordination among core courses and electives to reinforce these principles in multiple contexts.

- The Department will provide a broad background in biology for our students, ranging from the molecular level to the level of ecosystems.
- The Department will work to differentiate undergraduate from graduate education, since the goals and needs of these students differ.
- The Department will strive to provide an outstanding undergraduate education to our students. Faculty will work with students so that they get to know them personally, provide them opportunities to do research, to be mentored by more senior undergraduate and graduate students, and in turn encourage undergraduates to themselves serve as teachers and mentors to other students. The faculty will encourage the students to participate in interdisciplinary research projects within biology, and in areas that intersect with biology.

- The Department will strive to provide an outstanding graduate education to our students. Part of this depends directly on the excellence and strength of the faculty research enterprise, which will be crucial for attracting and supporting outstanding graduate students, and providing them with the research infrastructure to do outstanding work. The Department will strive to create separate graduate courses that emphasize the central themes and principles of Biology, and are not cross-listed with undergraduate courses. The Department will also provide common space for graduate students to foster the development of a strong "invisible college" across the different areas of biology, and to allow students to provide emotional and intellectual support for one another.